

# High-Speed, High-Temperature Finger Seal Test Evaluated

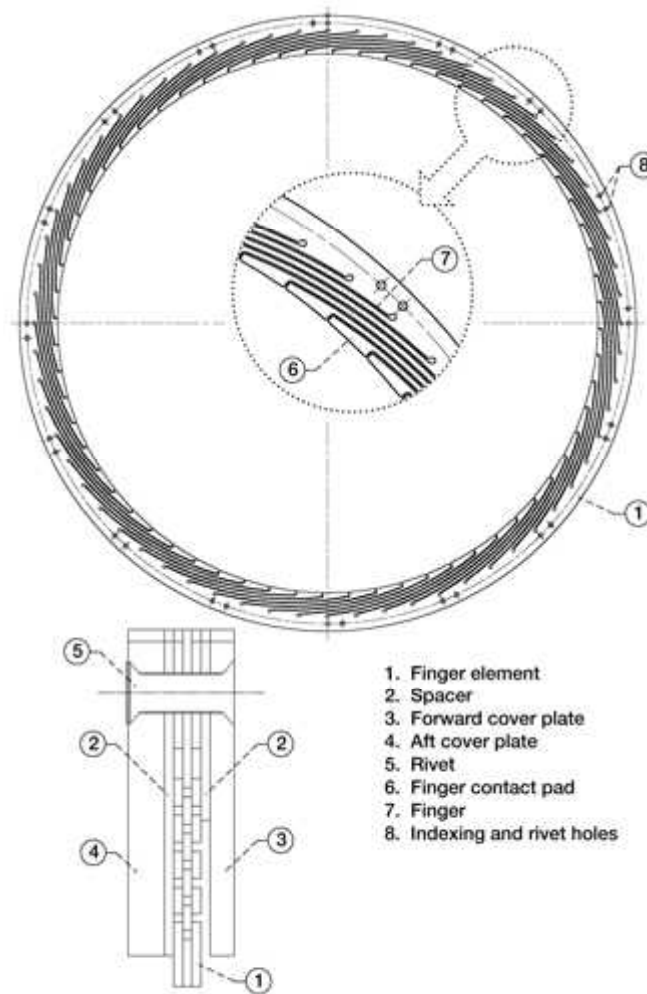


*High-temperature, high-speed turbine seal rig.*

A finger seal, designed and fabricated by Honeywell Engines, Systems and Services, was tested at the NASA Glenn Research Center at surface speeds up to 1200 ft/s, air temperatures up to 1200 °F, and pressures across the seal of 75 psid. These are the first test results obtained with NASA's new High-Temperature, High-Speed Turbine Seal Test Rig (see the photograph). The finger seal is an innovative design recently patented (ref. 1) by AlliedSignal Engines, which has demonstrated considerably lower leakage than commonly used labyrinth seals and is considerably cheaper than brush seals. The cost to produce finger seals is estimated to be about half of the cost to produce brush seals. Replacing labyrinth seals with fingers seals at locations that have high-pressure drops in gas turbine engines, typically main engine and thrust seals, can reduce air leakage at each location by 50 percent or more. This directly results in a 0.7- to 1.4-percent reduction in specific fuel consumption and a 0.35- to 0.7-percent reduction in direct operating costs (ref. 2). Because the finger seal is a contacting seal, this testing was conducted to address concerns about its heat generation and life capability at the higher speeds and temperatures required for advanced engines. The test results showed that the seal leakage and wear performance are acceptable for advanced engines (ref. 3).

The finger seal (see the following figure) is made of a stack of sheet stock elements shaped

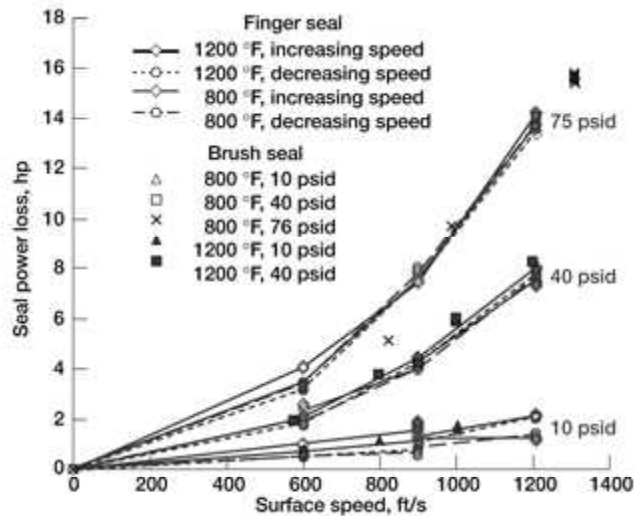
like washers. The center elements are machined to create a series of slender curved beams or fingers around the inner diameter. These finger elements are oriented so that the fingers of one element cover the spaces between the fingers of the adjacent element. Spacers and cover plates are placed on either side of the stack of finger elements, and the whole assembly is riveted together near the outer diameter of the stack. The fingers act like cantilever beams and flex away from the rotor to accommodate centrifugal and thermal growth and rotordynamic motions of the rotor. The cobalt-base alloy AMS5537, which combines good formability and excellent high-temperature properties, was used to make the finger seal. The 8.5-in.-diameter test rotor was made of MAR-M-247 and was coated with chrome carbide using high-velocity oxygen fuel thermal spraying.



*Finger seal design.*

The flow factor, which is an indicator of seal leakage performance, met or exceeded performance goals during endurance testing that simulated expected advanced-engine-rated power conditions. Most of the seal wear occurred in the initial performance test. The chrome carbide coating performed well, with a wear track depth less than 0.00025 in. The maximum finger seal power loss, which occurred at 1200 ft/s and 75 psid across the seal, was 14 hp. Further design improvements can be made to reduce the finger seal power loss.

Also, the finger seal power loss is comparable to the brush seal power loss as shown in the following graph.



*Finger seal and brush seal power loss versus speed at average seal inlet air temperatures of 800 and 1200 °F and pressure drops across the seal of 10-, 40-, and 75-psid.*

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**Glenn's Mechanical Components Branch**

<http://www.grc.nasa.gov/WWW/5900/5950/>

**Turbine Seals** <http://www.grc.nasa.gov/WWW/TurbineSeal/>

## References

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2. Steinetz, Bruce M.; Hendricks, Robert C.; and Munson, John: Advanced Seal Technology Role in Meeting Next Generation Turbine Engine Goals. NASA/TM--1998-206961, 1998.
3. Proctor, Margaret P.; Kumar, Arun; and Delgado, Irebert R.: High-Speed, High-Temperature Finger Seal Test Results. NASA/TM--2002-211589, 2002.

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